Fact Sheet

GAVRT–Cassini Jupiter Microwave Observing Campaign — JMOC

DEEP SPACE NETWORK

December 30, 2000, marks the close approach of the Cassini–Jupiter Millennium Flyby, when the Cassini spacecraft swings past the planet Jupiter on the way to Saturn for arrival in 2004. Another spacecraft, Galileo, has been exploring Jupiter since 1995. This is the first time in the history of space exploration that two robotic spacecraft will actively observe this gas giant planet at the same time from close range. While instruments on the Cassini spacecraft are conducting new observations of Jupiter, middle school and high school students from across the nation will be observing Jupiter using ground-based 34-meter-diameter radio telescopes at the Deep Space Network's Goldstone Complex. The students and their teachers are participants in the Goldstone–Apple Valley Radio Telescope (GAVRT) science education project, a partnership involving the National Aeronautics and Space Administration (NASA), the Jet Propulsion Laboratory (JPL), the Lewis Center for Educational Research (LCER) in Apple Valley, California, and the Apple Valley Unified School District.

The Cassini–JMOC Opportunity

From November 2000 through February 2001, GAVRT students and their teachers will join an *ad hoc* research team of space physicists, radio astronomers, digital microwave and software engineers, mission operation specialists, and others. The team will deliver to the Cassini Program a prescribed set of radio astronomy measurements that will enable the Cassini spacecraft to perform previously unplanned observations, enhancing science data return at Saturn.

The GAVRT activity is part of the Cassini–JMOC scientific investigation of Jupiter, involving a coordinated series of space-based and ground-based observations of the planet during the Cassini encounter from November 2000 through February 2001.

The Cassini Radar Receiver

The Cassini spacecraft carries a radar transmitter and receiver to perform radar imaging of Saturn's largest moon, Titan. The radar experiment, operating at 13.8 GHz, is designed to penetrate Titan's clouds and take images of the surface. The radar receiver can also perform as a passive radiometer to produce thermal emission (temperature) maps of the clouds of Saturn and the surface of Titan.

Space-Based JMOC Objectives

The Millennium Flyby presents a unique opportunity to perform special *in-flight* calibrations of the passive radiometer. As the spacecraft approaches Jupiter, radio emission from the giant planet will become "bright" enough to perform precision measurements using the 13.8-GHz Cassini radar receiver. The calibration will be accomplished by comparing the Cassini radiometer data with ground-based radio astronomy measurements of Jupiter that will be made throughout the flyby.

The Cassini spacecraft.

During the flyby, the Cassini radar instrument will also be used to observe and map the high-frequency (and therefore, high-energy) microwave emission from Jupiter's radiation belts for two Jovian rotations, a few days after closest approach on December 30, 2000. The proximity of the spacecraft to Jupiter during the flyby will provide adequate spatial resolution to "image" synchrotron emission very close to the planet. Synchrotron emission is radio frequency emission from extremely high-energy electrons trapped in Jupiter's magnetic field.

Cassini will map synchrotron emission from very high-energy (>25 MeV) electrons for the first time at 13.8 GHz. Ground-based maps to date have been limited to frequencies below ~10 GHz, where emission is produced by lower-energy electrons (<25 MeV).

The Ground-Based Objectives

The objectives of ground-based radio astronomy support throughout the Millennium Flyby are: (1) to provide precision

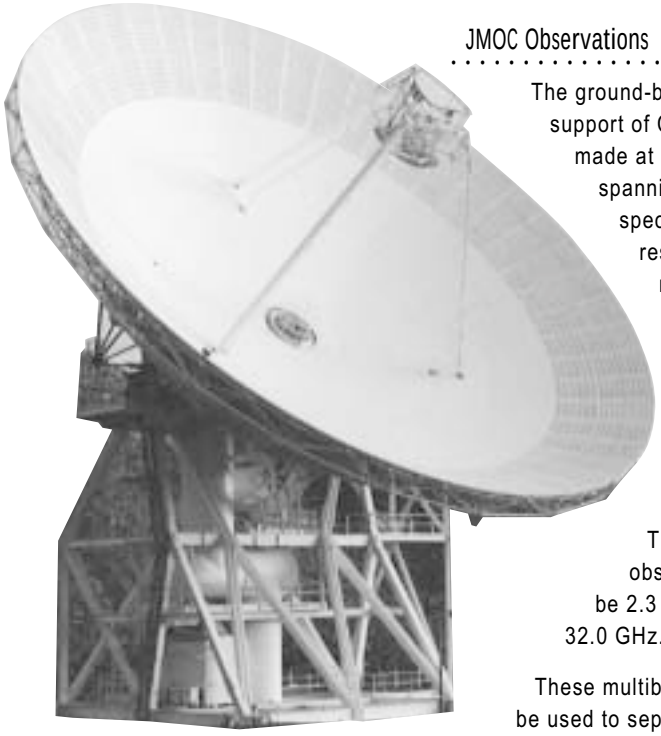
The Deep Space Network 34-meter antenna, DSS-12, at Goldstone, California.

measurements of Jupiter's radio emission at the Cassini radiometer frequency (13.8 GHz) using calibrated DSN antennas at Goldstone, and (2) to monitor time variations of the microwave radio emission from Jupiter's radiation belts. The goals of Cassini–JMOC are to enhance the science data return from the Cassini radiometer and simultaneously provide a new and unique opportunity for students to participate in an exciting scientific event.

An Opportunity for GAVRT

Teachers participating in JMOC will already be experienced in observing Jupiter, and GAVRT teachers and students have a strong track record of producing high-quality observation data. Students access the Mission Control Center at Apple Valley via the Internet and take control of the radio telescope from their classrooms. They record, analyze, and report their observations to the GAVRT Project and to JPL. For the Millennium Flyby, student results will also be reviewed by the Cassini–JMOC science team, and ultimately, reported to the Cassini Program.

Data gathered by the GAVRT students will be available on the World Wide Web and will form the basis for classroom lesson plans that can be enjoyed, without previous knowledge of radio astronomy, by students around the nation. Background materials are provided, and activities have been designed to enhance students' knowledge of Jupiter by introducing them to the concepts of radiation belts, polar auroras, and atmospheric thermal emissions.



The DSS-13 34-meter R&D antenna.

JMOC Observations

The ground-based observations in support of Cassini–JMOC will be made at several frequencies spanning the microwave spectrum. The 34-meter research and development (R&D) antenna (DSS-13) at NASA's Goldstone Deep Space Communications Complex (DSCC) will be used for the critical observations at 13.8 GHz. The other frequencies observed at Goldstone will be 2.3 GHz, 8.5 GHz, and 32.0 GHz.

These multiband observations will be used to separate the thermal and non-thermal components at 13.8 GHz, monitor time variations of the synchrotron emission, and measure the absolute flux density of Jupiter at calibrated radio astronomy wavelengths and then interpolate the absolute flux density at 13.8 GHz.

Jupiter's synchrotron emission is known to be time-variable, and there is plausible evidence that the observed variations are correlated with changes in solar wind parameters — for example, solar wind plasma density. The Cassini encounter with Jupiter will occur when solar activity is reaching the peak in the current 11-year cycle. The last large-scale (>20 percent) increase in Jupiter's synchrotron flux density, not counting the 1994 impact of the Shoemaker–Levy 9 comet, was observed in the winter of 1989–90, just about 11 years ago. If the correlation holds, one might expect the synchrotron component to surge in the near future. Both the Cassini and the Galileo spacecraft will be measuring the solar wind from different vantage points and looking for correlations with changes in Jupiter's magnetosphere and atmosphere. An unprecedented set of solar wind data will be produced, and the addition of synchrotron variability data from Cassini–JMOC could make an important contribution to the study.

The Cassini–JMOC science team is anticipating some exciting times during November 2000 through February 2001 when students are "on line" taking data during the Cassini-Jupiter Millennium Flyby.

For More Information

http://deepspace.jpl.nasa.gov/dsn/applevalley

http://www.avstc.org/gavrt

http://www.jpl.nasa.gov/jupiterflyby

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